Fixing the "Match": How to Play the Game

Purushottam A. Nagarkar, MD
Jeffrey E. Janis, MD

Introduction

Every year, more than 35 000 individuals compete for about 25 000 residency positions in the United States. Participants include medical students and individuals with prior graduate medical education. This process is managed by the National Resident Matching Program (NRMP), which promises "an impartial venue for matching applicants' preferences for residency positions with program directors' preferences for applicants."[1] This has not always been the case. When residencies were first introduced, around 1900, hospitals began competing with one another to secure the best residents as early as possible. By the 1940s, positions were being offered in the third-year of medical school. Students were making career decisions without adequate exposure to their options, and hospitals were making hiring decisions with little data. Medical schools attempted to prevent early offers by embargoing letters of reference. Hospitals responded by giving students shorter deadlines to accept offers. By 1949, exploding offers—valid for only 12 hours—were common. In 1952, a centralized clearing house for all residency offers, the NRMP, was created in an attempt to fix the market. *The Match*, as it came to be known, has evolved since then, although the underlying algorithm has remained basically unchanged.[2]

There has been much focus on the Match's effects on medical students' professional and ethical development,[3,4] but an analysis of Match strategy has been overlooked in the medical literature. This article investigates several aspects of the Match: Is there an optimal Match strategy? How should students and programs create rank lists? Would ethically troubling behaviors occur if students and programs employed optimal strategies? Could a change in NRMP rules reduce problematic behaviors and help the Match function better?

All authors are at University of Texas Southwestern Medical Center at Dallas. **Purushottam A. Nagarkar, MD,** is a Resident in the Department of Plastic Surgery; and **Jeffrey E. Janis, MD,** is Associate Professor in the Department of Plastic Surgery, Program Director of the Plastic Surgery Residency Program, and Chief of Plastic Surgery at Parkland Health and Hospital System.

Corresponding author: Jeffrey E. Janis, MD, University of Texas Southwestern Medical Center at Dallas, 1801 Inwood Road, Dallas, TX 75390, 214.645.8300, jeffrey.janis@utsouthwestern.edu

DOI: http://dx.doi.org/10.4300/JGME-D-11-00292.1

Ranking Strategies

The Algorithm

Any analysis of the Match must begin with its algorithm. The Match algorithm was fully described a decade after its introduction, by 2 economists, David Gale and Lloyd Shapley[5] (FIGURES 1 and 2). The algorithm is constructed as an iterative set of proposals: a student "proposes" to his top-ranked program, asking for a residency; the program accepts the proposal if it has an open spot, retaining the right to reject it later if a better suitor arrives. If the proposal is rejected, the student proposes to the next program on his list. If the proposal is accepted, another student repeats the process. Gale and Shapley[5] proved the algorithm to be optimal for the proposer. In the current Match, this means that students are *guaranteed* the best available program. Roth and Peranson[6] further showed that more than 99.9% of programs also have optimal outcomes.

Making Rank Lists

Gale and Shapley[5] proved that students should order their rank lists based *only* on their own preferences (*true-preference strategy)*. This is the best strategy for any student. Regardless of what other students or programs do, no other strategy can produce a better outcome. Not everyone realizes this. Advisors occasionally tell applicants to realistically consider their chances of matching at a program when determining its position on their rank lists. Following such advice, students might be tempted to give a "backup" program a high rank, if they are certain that it has ranked them first, so as not to risk losing a "sure thing." By doing so, they are denying themselves the chance of matching at a program they prefer more.

The true preference strategy is generally optimal for programs, but in about 0.1% of cases,[6] a program can improve its outcome with a shortened version of this list. The goal is to leave low-ranked students off the match list, causing a chain of rejections, which eventually results in a proposal from a more highly ranked student. However, this approach risks having unfilled positions. Avoiding that risk requires *perfect* information about the preferences of all other programs and students.[7,8] Because there is no a priori way for a program to know whether it falls in this 0.1% group, attempting to improve on the true-preference strategy is a one-in-a-thousand, high-stakes bet.

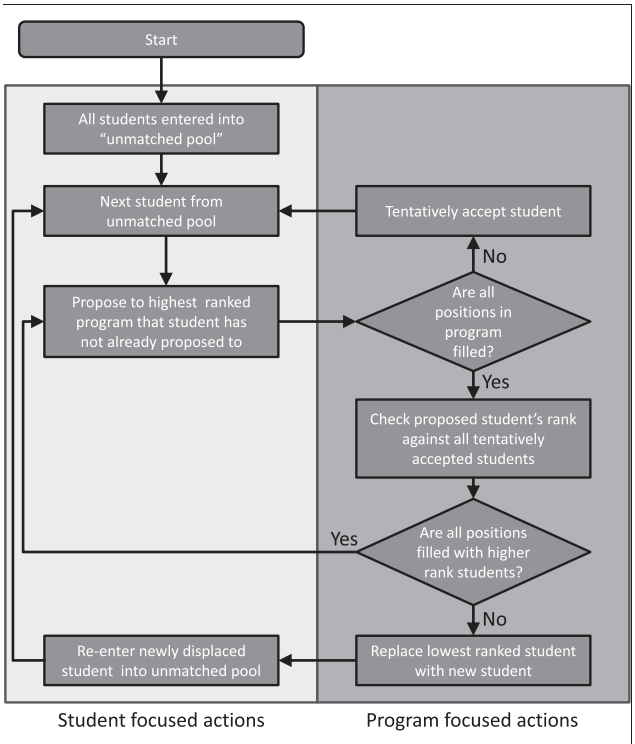

FIGURE 1 **Flowchart Depicting the Gale-Shapley Deferred-Acceptance Algorithm as Applied to the National Resident Matching Program (NRMP) Match**

Note that this is a simplified depiction because the actual Match has to take into account other factors, such as couples matching.

Suboptimal Strategies

Some programs do not appear to follow the true-preference strategy. A former member of the NRMP Board noted that program directors can modify their rank lists to raise the rank of the student who filled their last open position and that program directors take pride in this metric.[4] This strategy involves giving candidates who preferred their program a higher rank than could be justified by qualifications or interview performance. By doing this, programs may find that they reject a preferred candidate for a "backup" candidate. Put another way, with this strategy a program allows applicant preference to supersede its own, with the potential of a suboptimal Match result, to improve an artificial metric: the rank number of the last selected applicant.

Why would programs follow this strategy? Perhaps some programs assume that students' preference may affect their quality as a resident—that is, residents perform better at programs they have ranked highly. Unfortunately, no one has investigated the correlation between residents' objective performance and the program's position on *their* rank list. Further, even if this correlation existed, programs cannot know for certain where they are listed on a student's rank list.

This leads to the second reason that programs may rank students higher than their application status would merit: programs may focus on student preferences because they dislike the uncertainty of the Match. They may be willing to trade an optimal result for greater certainty. Students may do the same; that is, change the rank of a program based on their assessment of how high the program is likely to rank them. But certainty is an illusion. Because there are no binding agreements outside the Match and rank lists are confidential, "certainty" means placing trust in what your suitors tell you.

Unintended Incentives and Ethical Problems

Uncertainty may be the root of the angst regarding the Match. Participants value preference information because it may provide certainty, but they also distrust it because we all tell people what we think they want to hear.[9] For example, some programs call students to "express their interest," or to explicitly tell them that they are going to be highly ranked. Candidates sometimes latch onto these almost-promises and raise the rank of the calling programs.[10] Of course, this creates an incentive for every program to engage in that behavior. Interviewers sometimes ask students about their rank lists during interviews (this violates an NRMP rule, although interviewers may be unaware of it). Students, thinking that expressing enthusiasm could result in a better rank, regardless of their qualifications, feign great interest, even to programs they intend to rank low. In fact, Miller et al[3] noted that students who make misleading statements to programs tend to match at a higher rank.

In an effort to curtail such behavior by both programs and students in plastic surgery, the American Council of Academic Plastic Surgeons recently decided to limit postinterview communication between programs and candidates to the program coordinator and current residents.[10,11] Although it is a worthy goal to prevent unethical behaviors, the question remains, can the dissemination of false preference information affect the outcome of the Match?

The Impact of Lies and Honesty on Match Outcomes

Let's take the example of a student, Shannon, who has applied to 3 programs, A, B, and C (FIGURE 3). Her true preferences are (1) A, (2) B, (3) C. Suppose program C tells Shannon she is their top choice, and she changes her match list to (1) C, (2) A, (3) B. Unfortunately, Program C doesn't rank Shannon at all. As a result, her first "proposal," to C, is rejected. She proceeds to propose to program A and so on. The result is identical to her original match list.

FIGURE 2 **Example of a Simple Matching of 3 Students to 3 Programs**

Note: Each program has only 1 available position. Once all participants have submitted their lists (panel 1), the algorithm attempts to match each student to a program. Students propose to programs on their list—acceptance can result in a chain of rejections that necessitates further proposals from a student who was previously accepted (panels 2 through 7). In that case, all students are able to secure a position in one of the programs on their lists.

FIGURE 3 **Effect of Lying on Match Outcomes**

Therefore, this modification of the match list does not hurt Shannon: she was never going to match to program C, so her outcome is unchanged.

Now, assume program C does rank Shannon as their top choice. If Shannon submits her original rank list (her true preferences), she will have a chance of matching at A or B, and if she does not, her proposal to C is sure to be accepted. However, under her modified rank list, Shannon will definitely match with program C, and lose any chance of matching at A or B. So although Shannon is not affected by program C by lying, she may be worse off if she changes her rank list based on C's apparent preference. This logic works equally well for programs. Programs that raise a student's rank, based on a student's false expression of preference, are not harmed. In short, overstating preference never hurts the party being lied to.

On the other hand, suppose a program learns that a student plans to rank it low, and lowers his rank below his original position. This program has decreased the student's likelihood of matching with it, which is possible even if he has given the program a low rank (in 2009, 12% of applicants matched to a program ranked outside their top 4[12]) and increased its own likelihood of being matched to an objectively worse candidate. If optimal strategies are not being followed, providing honest preference information may produce worse outcomes for both students and programs. In this situation, where programs do not follow their true preferences, students will have an incentive to disguise their preferences to maximize student preference outcomes.

Although lies may not affect Match outcomes, they present ethical and practical problems. Rank lists may be confidential, but lies (or exaggerations) are easily discovered, and no one likes being misled. In the long term, these actions can easily hurt a program's—or a student's—reputation.

Removing Incentives for Dishonesty

Based on this analysis, there are 4 important conclusions: (1) rank lists should always be true preference lists, (2) lying about preferences cannot affect Match outcomes, (3) the incentive to lie arises because some programs consider student preferences when assigning ranks (and vice versa), and (4) in the long term, lying about preference is problematic. Ideally, the incentives for students and programs to be dishonest should be minimized.

Part of the solution is education. Students should have clear and consistent information about optimal ranking strategies. If students stop considering program preferences, programs will have fewer reasons to mislead students. Similarly, decreasing the incentive for students to mislead programs will require programs to stop considering student preferences. This may be more difficult. Student behavior may be due to inexperience with the Match, but programs have had decades to learn about the process. Changing their behavior may require a redesign of NRMP rules.

The postinterview period presents an opportunity for such reform. If programs had to submit their rank lists before they could communicate with students, the incentive for students to lie about preferences would be removed. This could be done with 2 changes: (1) the submission deadlines for the program rank lists could be moved to an earlier date, without changing the student deadline; and (2) programs would have to be banned from communicating with candidates until after the submission deadline for the program's rank list. By banning all conversations, instead of certain topics, candidates would not have to parse a caller's words to detect a violation of the rules. This would allow ample recruiting activities without putting students in difficult situations. As mentioned previously, the American Council of Academic Plastic Surgeons already disallows any communication between plastic surgery programs and residency candidates after interviews.[10,11] It would behoove other specialties to take similar steps and, thus, reduce the incentives for unethical behaviors for both candidates and programs.

Conclusion

The Match has been criticized for exploiting a power differential and for promoting cynicism, manipulation, and distrust.[4,13,14] Yet after examining the Match algorithm and its strategic implications, it is clear that the primary flaw is not in the system. First, the Match dilutes the traditional power differential between employer and job seeker because its algorithm guarantees optimal outcomes. "Playing the game" does not require lies or misdirection; listing true preferences is the ideal strategy for all players. Employing this strategy provides ironclad protection from manipulation, and the algorithm even protects players using suboptimal strategies from being harmed by exaggerations about preferences. The Match is a beautifully designed system: to function best, it requires only that all

←

Note: On the left, Shannon modifies her true-preference rank list from (1) A, (2) B, (3) C to (1) C, (2) A, (3) B. Program C ranks her as their top choice. This results in a match for Shannon with program C and incidentally affects the final outcome for Steve and John. Shannon has now matched to a program she prefers less than the program she would have matched with had she submitted her true preference list. On the right, Shannon modifies her rank list, but program C does not rank her at all. The outcome is identical to the outcome in FIGURE 2. Note that intervening steps in the algorithm identical to those seen in FIGURE 2 have been omitted from this FIGURE.

participants act in a purely selfish manner. If programs and students can accept a degree of uncertainty as the price of optimum performance and simply behave in their own best interests, they will soon realize that the ''game'' they are playing is more solitaire than poker.

References

1 National Resident Matching Program. Residency match. http://www.nrmp.org/res_match/index.html. Updated August, 3, 2011. Accessed March 16, 2011.
2 Roth AE. The origins, history, and design of the resident match. *JAMA*. 2003;289(7):909–912.
3 Miller JB, Schaad DC, Crittenden RA, Oriol NE, MacLaren C. Communication between programs and applicants during residency selection: effects of the match on medical students' professional development. *Acad Med*. 2003;78(4):403–411.
4 Fisher CE. A piece of my mind: manipulation and the match. *JAMA*. 2009; 302(12):1266–1267.
5 Gale D, Shapley L. College admissions and the stability of marriage. *Am Math Mon*. 1962;69(1):9–15.
6 Roth AE, Peranson E. The redesign of the matching market for American physicians: some engineering aspects of economic design. *Am Econ Rev*. 1999;89(4):748–780.
7 Gale D, Sotomayor M. Ms Machiavelli and the stable matching problem. *Am Math Mon*. 1985;92(4):261–268.
8 Roth AE, Rothblum UG. Truncation strategies in matching markets—in search of advice for participants. *Econometrica*. 1999;67(1):21–43.
9 Anderson KD, Jacobs DM. General surgery program directors' perceptions of the match. *Curr Surg*. 2000;57(5):460–465.
10 Opel D, Shugerman R, McPhillips H, Swanson WS, Archibald S, Diekema D. Professionalism and the match: a pediatric residency program's postinterview no-call policy and its impact on applicants. *Pediatrics*. 2007;120(4):e826–e831.
11 Lawrence WT. The history of the Association of Academic Chairmen in Plastic Surgery: 1990 to 2004. *Plast Reconstr Surg*. 2008;121(1):320–327.
12 [NRMP] National Resident Matching Program. *National Resident Matching Program, Results and Data: 2009 Main Residency Match. National Resident Matching Program*. Washington, DC: NRMP; 2009.
13 McAliser RP. An opportunity for professionalism in the match. *Obstet Gynecol*. 2003;102(6):1220–1221.
14 Lewis LD, Wagoner NE. Professionalism and the match. *N Engl J Med*. 2003;349(6):615–616.